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size used in Birmingham, often intermittently, renders the system peculiarly applicable to that city. Although each thousand horse-power at the central station may produce only five hundred horse-power at the users' engines, it will displace fully a thousand horse-power of small boiler plant, etc., while the centralization of the power-producing plant admits of the conversion of fuel into power under conditions most favorable to economy and efficiency.

#### THE MENTAL FACULTIES AND SOCIAL INSTINCTS OF APES.

A WRITER in the *Revue scientifique* (Aug. 28, 1886) has made an admirable *résumé* of the suggestive analogies between the mental habits of the higher quadrumana and those of low savage tribes, and to some extent of civilized children. The importance of this stage in mental evolution has not been overlooked; but much of the material is unreliable, and direct observations by good observers are few. Mme. Clémence Royer gives copious references to the best of these observers, and thus succeeds in making a useful presentation of the subject in a very few pages. Even the mere summary which is here to follow, of the points in common to the ape and the savage man, will be sufficient to impress one with the far-reaching extent and real significance of this comparison.

*Sociability and the family.* — The degree of sociability varies greatly in different species. The gorillas of West Africa live in small patriarchal families, while the cynocephalus and many American species live in troupes, without any definite sexual relations. Savage tribes showing each of these forms of family life have been described. Houzeau remarks that the patriarchal system is maintained among many of the anthropoid apes by subordination to the authority of a chief. Each group has but one chief, — an adult male. The females and young ones are subject to his control until they tire of this dependence, and abandon or kill the ruler. Among the chimpanzees and gorillas, even smaller families, with a single pair at the head, are found; and here the feelings of maternal and conjugal love are developed to a high degree. Paternal affection is rare, but many savages do not recognize the right of the father. It is common to find them tracing descent through the female line only, without any regard to paternal instincts. Three authenticated examples of conjugal love among apes are recorded.

*Language.* — By this term must be understood, not a finished systematized speech, but simply some rudimentary mode of expressing emotional

and mental states by sounds and gestures. Apes, of course, have cries for all their common emotions, — their desires, their fears, pains and pleasures. These cries differ considerably in different species. Houzeau records an instance in which the animal used a special cry when it was displeased by having an object given to it which was not the one it wanted.

The faculty for imitation is certainly characteristic of the quadrumana, and has given us the phrase 'to ape.' It is a trait common to savages, to children, and to idiots; in short, to low-type, undeveloped minds. The attitudes and general conduct of apes are so human, that some savages believe that it is only out of spitefulness that they do not speak. But even this poverty of sounds is not without parallel in savages: many have a very meagre alphabet of sounds, and help themselves out with clicks and natural noises. All apes (except, perhaps, the orang-outang) have voice: they often repeat sounds, which are usually complex articulations involving gutturals and harsh sounds, with little variation. But the New-Zealanders lack twelve of our consonants, and other tribes show similar imperfections. And, curiously, it is just the labials so often found absent in the languages of the lowest species of men that are never used by apes. But the labial *m* is almost the first sound learned by the civilized chief, as is shown in the word 'mamma.'

Apes readily understand our language sufficiently to be tamed, and trained to astonishing performances; and they are guided by sound as well as by gesture. Perhaps they understand our language somewhat as a child of fifteen or eighteen months understands its mother. But of course they lack every trace of a method of recording mental conditions. If the most primitive savage had not had some sort of record-making, even so simple as the Peruvian *quipus*, we could hardly know of his existence.

The phrase of Rabelais, that 'laughing is a peculiarity of the genus Homo,' is shown false by the evidence of this power in apes. It may be noted that many half-civilized people laugh very seldom, such as the Turks. One can readily read the expression on an ape's countenance. They weep too, and have been observed to frown.

*Fêtes and funeral rites.* — Houzeau likens the assemblages observed among the quadrumana to those of the Hottentots and other people. The apes of South America, when they have drained the resources of a certain area, have a re-union before they decide to emigrate. They jump and run and shout; the males running along the trees, while the females carry the young ones in their arms. Stories are told of the regularity

with which such re-unions are held. In Africa the apes, on such occasions, collect sticks, and make a noise by hammering on the trees: the analogy with primitive music-making is sufficiently evident.

The Chinese tell of a species of ape that accompanies the body of a deceased member to its final resting-place, but this may be doubted. The Caffres of Africa, however, do not take the trouble of burying their dead, except in the case of chiefs or children.

*Weapons and contests.*—Apes, like men, fight and kill one another. The leader is the one who has shown his strength. When the male gorillas grow up, and have gained the full degree of their power, they attack the old ones, and do not leave the field until the issue has been decided. The abandoning of the aged is a custom in many tribes. Herodotus records it of certain people of Scythia. The gap between the lowest human morality and that of animals is small indeed.

Their fights are mostly hand to hand, with an active use of their canines, though some species very seldom bite. The Spartans are said to have fought with tooth and nail when deprived of their arms. The gorilla's method of attack is most nearly human. He raises a cry like the war-whoop of savages, and, beating his breast with his hands, rushes with savage ferocity upon his antagonist. With the exception of the gorilla, the quadrumanous fear man, but do not hesitate to attack him in self-defence.

The hurling of projectiles, whether lances, tomahawks, or clubs, and so on, is common to all savages, and is likewise found among apes. They tear off branches of trees and use them as arms, or take refuge in the trees and hurl fruit at their enemy. This means of attack is found even in high degrees of civilization, as in the middle ages, and is made use of by animals (e.g., elephants) lower in the animal scale.

*Friendship, enmities, etc.*—Individual preferences can be observed among apes at any zoölogical garden. Their affection for their keepers is well known. They have aversions too, sharing with man the dread of snakes. Tribal enmities are also observed: the orang-outang has an instinctive animosity against almost all other apes. Similar feuds abound in savage tribes. Apes readily show temper, and have often been compared to spoiled children. Their anger is expressed by cries and wild gesticulations.

Apes readily drink wine when it is given them, and quite as readily drink to excess. Their conduct, when inebriated, is closely similar to that of man in the same condition.

Though antipathies are common between apes

of different species, friendly assistance is often shown among apes of the same species. They join to ward off a common danger. The hand is the great means of giving aid: we have the expression 'to lend a hand.' It is true in a general way that species provided with organs of apprehension are sociable. Apes often plan attacks on orchards, etc., reach inaccessible places by forming a living chain and bridging themselves over, and seem to delight in the act of theft. They have been observed to take care of the wounded, to wash and cover their wounds with leaves, and to nurse them.

*Intelligence.*—The possession of acute sensibility for foreseeing danger, and the like, is a common animal trait, not wanting in apes. The similar sagacity of savages, e.g., our own Indians, is well known. Apes soon learn the danger of fire-arms; and the story is told of one who dropped from a tree when he saw that his assailants were armed, apparently giving himself up as dead.

An ape's curiosity and power of fixed attention are well known: these qualities are necessary to make a good imitation. In several cases they have observed the use of a lock and key, and made use of their knowledge in secret. Chimpanzees have been taught to eat with a knife and fork, and learn similar human customs. Their tendency to pilfer is another point in common with savages and children.

*Industry.*—Man has been called the tool-using animal; but apes have been observed to use a stone for opening nuts too hard for their teeth. Erasmus Darwin tells of an old ape who had lost his teeth, and always used a stone to open nuts.

Apes can be taught to mount and guide horses and dogs; and one traveller tells a story of an ape who learned this of his own accord, thus reminding one of the savage's method of procuring horses. Humboldt records similar observations. The stories of apes kindling fires are unreliable, though they often keep up fires deserted by natives or travellers.

*Domestic services.*—Apes have been used for carrying water and as bearers of messages. A French officer tells of the services of a chimpanzee aboard ship. It helped turn the capstan, climbed the masts, tied the ropes, and performed other functions. But only a few species are adapted for such an education.

Richard Owen, comparing the psychic condition of a chimpanzee with that of a Bushman or an idiot, finds no clear dividing-mark. It is only a difference of degree. Agassiz finds a complete resemblance between the mental faculties of an infant and of a young chimpanzee. It is only by the greater development of the former that it

becomes human with all the great distinctions of that term.

#### ANTHROPOMETRICAL TESTS.

SINCE Mr. Francis Galton conducted his anthropometrical measurements at the International health exhibition, increased attention has been given to the measurement of physical characteristics and of the senses. Mr. Galton has received letters from Tokio, from Rome, from Paris, and elsewhere, asking for the necessary apparatus for establishing a laboratory where the important measurements of the body and testing of the senses can be made.

The importance of such observations is well understood. It will enable us to determine accurately racial characteristics, to mark the stages of individual growth, to detect abnormalities of development in time to check them, to lay the foundation for a rational education of the senses and the muscles.

Mr. Galton has been devoting much time to the preparation of instruments for measuring the head and the delicacy of the senses; and Mr. Horace Darwin, of the Cambridge scientific instrument co., has aided him in the work. The last Journal of the Anthropological institute of Great Britain contains a preliminary account of some of their devices.

As regards the size of the head, it is well known that the caps of university students are larger than those of the uneducated population. With a convenient method of determining the size of the head in various directions, one could find at what age generally and individually the growth of the brain comes to a standstill. The method of taking the measurements is still a matter of controversy. The maximum breadth can be gotten by a pair of calipers, with rough teeth, like those of a comb, to penetrate the hair. The maximum length from the glabella (the central point between the eyebrows) is also easy to measure. The great difficulty is in getting the height of the head. Mr. Darwin's instrument for this purpose is inserted into the two ear-holes, and a slight projection is caught by the inner edges of the orbits: this determines the horizontal plane, and measurements are taken to either side from it. He will improve the instrument by having a band attached, to be inserted under the chin, and thus press the frame close against the orbit.

For the color of the eyes and hair, Mr. Galton suggests, instead of printed shades, which are apt to fade, small disks of colored glass for the eyes, and spun threads of this glass for matching the hair.

The usual form of dynamometer for measuring the force of one's grip is objectionable, because the maximum clutch depends on the width and convenience of the instrument at its widest point. Mr. Darwin is making an instrument to avoid this defect.

With regard to sight, Mr. Galton admitted that there was no good recognized way of measuring the acuteness of vision, but thought the simple method of getting the distance at which one can tell in what corner of a white card a black dot is to be found, as good as any. Mr. Brudenell Carter, who has published some interesting views on the relation of eyesight to civilization, objected to this method, and preferred the test of distinguishing two closely adjoining dots. There are many good methods of testing the color-sense; and Dr. Cattell's experiments at Leipzig, on the time it takes to perceive the various colors, are of interest here. He found that it requires 8 ten-thousandths of a second to see orange, 10 to see yellow, 12 to see blue, 13 to see red, 14 to see green, 23 to see violet. The exposure was made by an arrangement similar to the instantaneous shutter of a camera. Great individual differences in the perception of various colors appeared, and a simple form of his apparatus might be useful for testing the color-sense.

With regard to sounds, we have almost no exact methods of measuring. The susceptibility to pitch can be readily measured.

Mr. Darwin also exhibited before the Anthropological society an ingenious contrivance for measuring one's reaction time, which works on the principle of snapping a rod, and arresting it in its fall as soon as possible after the sound is heard.

The subject is really one of the highest practical importance, and physiological as well as mechanical problems are involved. A physiologist with a mechanical bent would certainly find here a fruitful field.

#### THE STUDY OF THE SENSES.

THE great name of Helmholtz stands for the union of the physical and biological sciences. The late Professor Clifford speaks of him as "the physiologist who learned physics for the sake of his physiology, and mathematics for the sake of his physics, and is now in the first rank of all three." In his 'Physiological optics' and his analysis of the 'Sensations of tone,' he gave to the world two classical works, as invaluable to the physicist as to the psychologist and physiologist. The real greatness of these studies, the new engine that he employed, consisted in recognizing the dual nature